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ECONOMICS

ELEVENTH
EUROPEAN EDITION

ECONOMICS

10 Output and Costs

After studying this chapter you will be able to:

- Distinguish between the short run and the long run
- Explain the relationship between a firm's output and labour employed in the short run
- Explain the relationship between a firm's output and costs in the short run and derive a firm's short-run cost curves
- Explain the relationship between a firm's output and costs in the long run and derive a firm's long-run average cost curve

Behind the scenes of an Amazon fulfilment centre, many economic decisions have been made that affect the firm's cost of production. Amazon has decided how many people to employ and how many and what size fulfilment centres to build. How does Amazon make these decisions?

We will find out in this chapter and look at how recent expansion decisions by Amazon affect the firm's production costs in *Economics in the News* at the end of the chapter. But first, we'll study the costs of a simpler, smaller firm, Campus Sweaters, a (fictional) producer of knitwear.

Time Frames for Decisions

People who operate firms make many decisions. All of these decisions are aimed at one overriding objective: maximum attainable profit. But the decisions are not all equally critical. Some of the decisions are big ones. Once made, they are costly (or impossible) to reverse. If such a decision turns out to be incorrect, it might lead to the failure of the firm. Some of the decisions are small ones. They are easily changed. If one of these decisions turns out to be incorrect, the firm can change its actions and survive.

The biggest decision that an entrepreneur makes is in what industry to establish a firm. For most entrepreneurs, their background knowledge and interests drive this decision. But the decision also depends on profit prospects – on the expectation that total revenue will exceed total cost.

Norma has decided to set up Fashion First to produce jumpers. She has also decided the most effective method of organisation. But she has not decided the quantity to produce, the quantities of factors of production to hire, or the price to charge for jumpers.

Decisions about the quantity to produce and the price to charge depend on the type of market in which the firm operates. Perfect competition, monopolistic competition, oligopoly and monopoly all confront the firm with *different* problems.

But decisions about *how* to produce a given output do not depend on the type of market in which the firm operates. These decisions are similar for *all* types of firms in *all* types of markets.

The actions that a firm can take to influence the relationship between output and cost depend on how soon the firm wants to act. A firm that plans to change its output rate tomorrow has fewer options than one that plans to change its output rate six months from now.

To study the relationship between a firm's output decision and its costs, we distinguish between two decision time frames:

- Short run
- Long run

Short Run

The **short run** is a time frame in which the quantity of at least one factor of production is fixed. For most firms, capital, land and entrepreneurship are fixed factors of production, and labour is the variable factor of production. We call the fixed factors of production the firm's *plant.* So in the short run, a firm's plant is fixed. Fashion First's fixed plant is its factory building and its knitting machines. For an electric power utility, the fixed plant is its buildings, generators, computers and control systems.

To increase output in the short run, a firm must increase the quantity of a variable factor of production, which is usually labour. So to produce more output, Fashion First must hire more labour and operate its knitting machines for more hours per day. Similarly, an electric power utility must hire more labour and operate its generators for more hours per day.

Short-run decisions are easily reversed. The firm can increase or decrease output in the short run by increasing or decreasing the labour it hires.

Long Run

The **long run** is a time frame in which the quantities of *all* factors of production can be varied. That is, the long run is a period in which the firm can change its *plant.*

To increase output in the long run, a firm is able to choose whether to change its plant as well as whether to increase the quantity of labour it hires. Fashion First can decide whether to install some additional knitting machines, use a new type of machine, reorganise its management or hire more labour. An electric power utility can decide whether to install more generators. And an airport can decide whether to build more runways, terminals and traffic-control facilities.

Long-run decisions are *not* easily reversed. Once a plant decision is made, the firm must live with it for some time. To emphasise this fact, we call the *past* expenditure on a plant that has no resale value a **sunk cost**. A sunk cost is irrelevant to the firm's current decisions. The only costs that influence its current decisions are the short-run cost of changing the quantity of labour and the long-run cost of changing its plant.

REVIEW QUIZ

1 Distinguish between the short run and the long run.
2 Why is a sunk cost irrelevant to a firm's current decisions?

Do these questions in Study Plan 10.1 and get instant feedback. Do a Key Terms Quiz. MyLab Economics

We're going to study costs in the short run and the long run. We begin with the short run and describe the technology constraint the firm faces.

Short-Run Technology Constraint

To increase output in the short run, a firm must increase the quantity of labour employed. We describe the relationship between output and the quantity of labour employed by using three related concepts:

1 Total product
2 Marginal product
3 Average product

These product concepts can be illustrated either by product schedules or by product curves.

Product Schedules and Curves

Table 10.1 shows some data that describe Fashion First's total product, marginal product and average product. The numbers tell us how Fashion First's production changes as more workers are employed, for a fixed level of plant and machines. They also tell us about the productivity of Fashion First's workforce.

Look first at the columns headed 'Labour' and 'Total product'. **Total product** is the maximum output that a given quantity of labour can produce. The table shows how total product increases as Fashion First employs more labour. For example, when Fashion First employs 1 worker, total product is 4 jumpers a day, and when Fashion First employs 2 workers, total product is 10 jumpers a day. Each increase in employment brings an increase in total product.

The **marginal product** of labour is the increase in total product resulting from a one-unit increase in the quantity of labour employed with all other inputs remaining the same. For example, in Table 10.1, when Fashion First increases employment from 2 to 3 workers and does not change its capital, the marginal product of the third worker is 3 jumpers – total product increases from 10 to 13 jumpers.

The **average product** tells how productive workers are on the average. The average product of labour is equal to total product divided by the quantity of labour employed. For example, in Table 10.1, 3 workers can knit 13 jumpers a day, so the average product of labour is 13 divided by 3, which is 4.33 jumpers per worker.

If you look closely at the numbers in Table 10.1, you can see some patterns. For example, as Fashion First employs more workers, marginal product at first increases and then begins to decrease. For example, marginal product increases from 4 jumpers a day for the first worker to 6 jumpers a day for the second worker and then decreases to 3 jumpers a day for the third worker. Also average product at first increases and then decreases.

Table 10.1

Total Product, Marginal Product and Average Product

	Labour (workers per day)	Total product (jumpers per day)	Marginal product (jumpers per worker)	Average product (jumpers per worker)
A	0	0		
			4	
B	1	4		4.00
			6	
C	**2**	**10**		5.00
			.....**3**	
D	**3**	**13**		**4.33**
			2	
E	4	15		3.75
			1	
F	5	16		3.20

Total product is the total amount produced. Marginal product is the change in total product resulting from a one-unit increase in labour. For example, when labour increases from 2 to 3 workers a day (row *C* to row *D*), total product increases from 10 to 13 jumpers a day. The marginal product of going from 2 to 3 workers is 3 jumpers. (Marginal product is shown between the rows because it is the result of a change in the quantity of labour.) Average product of labour is total product divided by the quantity of labour employed. For example, 3 workers produce 13 jumpers a day, so the average product of 3 workers is 4.33 jumpers per worker.

You can see the relationships between the number of workers employed and the three product concepts more clearly by looking at the product curves.

A firm's product curves are graphs of the relationships between employment and the three product concepts that you've just studied. They show how total product, marginal product and average product change as employment changes. They also show the relationships among the three concepts. Let's look at the three product curves, starting with total product.

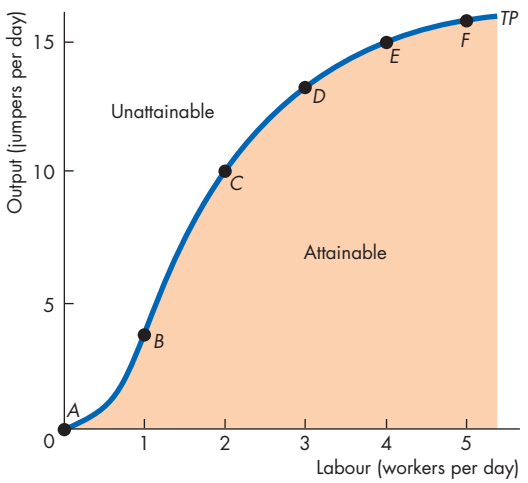
Total Product Curve

Figure 10.1 shows Fashion First's total product curve, *TP*. As employment increases, so does the number of jumpers knitted. Points *A* to *F* on the curve correspond to the same rows in Table 10.1. These points show total product at various quantities of labour per day. But labour is divisible into hours and even minutes. By varying the amount of labour in the smallest units possible, we can draw the total product curve shown in Figure 10.1.

Look carefully at the shape of the total product curve. As employment increases from zero to 1 worker a day, the curve becomes steeper. Then, as employment continues to increase to 3, 4 and 5 workers per day, the curve becomes less steep.

The total product curve is similar to the *production possibilities frontier* (explained in Chapter 2). It separates the attainable output levels from those that are unattainable. All the points that lie above the curve are unattainable. Points that lie below the curve, in the orange area, are attainable. But they are inefficient – they use more labour than is necessary to produce a given output. Only the points *on* the total product curve are technologically efficient.

Figure 10.1 Total Product Curve



The total product curve (*TP*) is based on the data in Table 10.1. The total product curve shows how the quantity of jumpers changes as the quantity of labour employed changes. For example, using 1 knitting machine, 2 workers can produce 10 jumpers a day (row *C*). Points *A* to *F* on the curve correspond to the rows of Table 10.1. The total product curve separates the attainable output from the unattainable output. Points on the *TP* curve are efficient.

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Marginal Product Curve

Figure 10.2 shows Fashion First's marginal product of labour with 1 knitting machine. Part (a) reproduces the total product curve from Figure 10.1. Part (b) shows the marginal product curve, *MP*.

In Figure 10.2(a), the orange bars illustrate the marginal product of labour. The height of each bar measures marginal product. Marginal product is also measured by the slope of the total product curve. Recall that the slope of a curve is the change in the value of the variable measured on the *y*-axis – output – divided by the change in the variable measured on the *x*-axis – labour – as we move along the curve. A one-unit increase in labour, from 2 to 3 workers, increases output from 10 to 13 jumpers, so the slope from point *C* to point *D* is 3 jumpers per worker, the same as the marginal product that we've just calculated.

By varying the amount of labour in the smallest imaginable units, we can draw the marginal product curve shown in Figure 10.2(b). The *height* of this curve measures the *slope* of the total product curve at a point. The total product curve in part (a) shows that an increase in employment from 2 to 3 workers increases output from 10 to 13 jumpers (an increase of 3). The increase in output of 3 jumpers appears on the *y*-axis of part (b) as the marginal product of going from 2 to 3 workers. We plot that marginal product at the mid-point between 2 and 3 workers. Notice that marginal product in Figure 10.2(b) reaches a peak at 1.5 workers and at that point marginal product is 6 jumpers. The peak occurs at 1.5 workers because the total product curve is steepest when employment increases from 1 to 2 workers.

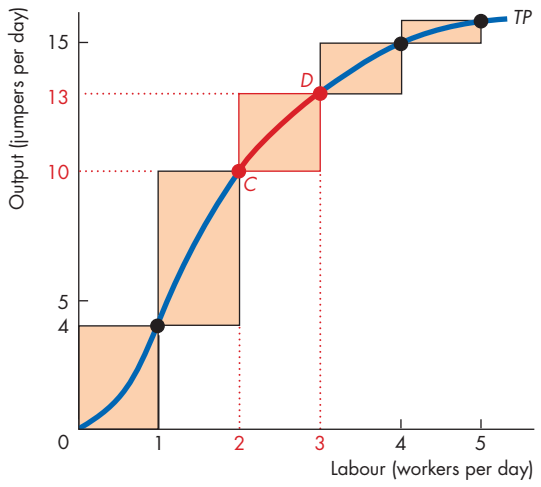
The total product and marginal product curves differ across firms and types of goods. An airline's product curves are different from those of your local supermarket, which in turn are different from those of Fashion First. But the shapes of the product curves are similar because almost every production process has two features:

- Increasing marginal returns initially
- Diminishing marginal returns eventually

Increasing Marginal Returns

Increasing marginal returns occur when the marginal product of an additional worker exceeds the marginal product of the previous worker. Increasing marginal returns arise from increased specialisation and division of labour in the production process.

Figure 10.2 Total Product and Marginal Product



(a) Total product

(b) Marginal product

Marginal product is illustrated in both parts of the figure by the orange bars. For example, when labour increases from 2 to 3 workers a day, marginal product is the orange bar whose height is 3 jumpers. (Marginal product is shown midway between the quantities of labour to emphasise that it is the result of changing the quantity of labour.)

The steeper the slope of the total product curve (*TP*) in part (a), the larger is marginal product (*MP*) in part (b). Marginal product increases to a maximum (in this example when the second worker is employed) and then declines – diminishing marginal product.

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For example, if Fashion First employs just 1 worker, that person has to learn all the different aspects of jumper production: running the knitting machines, fixing breakdowns, packaging and mailing jumpers, and buying and checking the type and colour of the wool. All of these tasks have to be done by that one person.

If Fashion First employs a second person, the 2 workers can specialise in different parts of the production process. As a result, 2 workers produce more than twice as much as 1. The marginal product of the second worker is greater than the marginal product of the first worker. Marginal returns are increasing.

Diminishing Marginal Returns

Most product processes experience increasing marginal returns initially, but all production processes eventually reach a point of diminishing marginal returns. **Diminishing marginal returns** occur when the marginal product of an additional worker is less than the marginal product of the previous worker.

Diminishing marginal returns arise from the fact that more and more workers are using the same capital and working in the same space. As more workers are added, there is less and less for the additional workers to do that is productive. For example, if Fashion First employs a third worker, output increases but not by as much as it did when it added the second worker. In this case, after two workers are employed, all the gains from specialisation and the division of labour have been exhausted. By employing a third worker, the factory produces more jumpers, but the equipment is being operated closer to its limits. There are even times when the third worker has nothing to do because the machine is running without the need for further attention. Adding more and more workers continues to increase output but by successively smaller amounts. Marginal returns are diminishing. This phenomenon is such a pervasive one that it is called 'the law of diminishing returns'.

The **law of diminishing returns** states that:

As a firm uses more of a variable factor of production, with a given quantity of the fixed factor of production, the marginal product of the variable factor eventually diminishes.

You will return to the law of diminishing returns when we study a firm's costs. But before we do, let's look at average product and the average product curve.

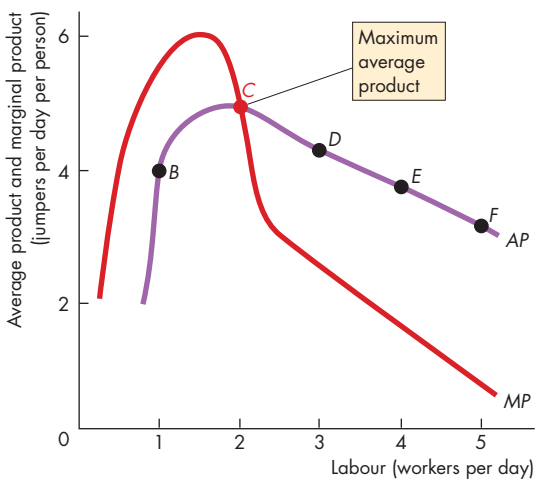
Average Product Curve

Figure 10.3 illustrates Fashion First's average product of labour, *AP*, and the relationship between the average and marginal product. Points *B* to *F* on the average product curve correspond to those same rows in Table 10.1.

Average product increases from 1 to 2 workers (its maximum value is at point *C*) but then decreases as yet more workers are employed. Also, average product is largest when average product and marginal product are equal. That is, the marginal product curve cuts the average product curve at the point of maximum average product. For the number of workers at which the marginal product exceeds average product, average product is *increasing*. For the number of workers at which marginal product is less than average product, average product is *decreasing*.

The relationship between the average product and marginal product curves is a general feature of the relationship between the average and marginal values of any variable. Let's look at a familiar example.

Figure 10.3 Average Product



The figure shows the average product of labour and the connection between the average product and marginal product. With 1 worker a day, marginal product exceeds average product, so average product is increasing. With 2 workers a day, marginal product equals average product, so average product is at its maximum. With more than 2 workers a day, marginal product is less than average product, so average product is decreasing.

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ECONOMICS IN ACTION

How to Pull Up Your Average

Do you want to pull up your average mark? Then make sure that your mark on this test is better than your current average! This test is your marginal test. If your marginal mark exceeds your average mark (like the second test in the graph), your average will rise. If your marginal mark equals your average mark (like the third test in the graph), your average won't change. If your marginal mark is below your average mark (like the fourth test in the figure), your average will fall.

The relationship between your marginal and average grades is exactly the same as that between marginal product and average product.

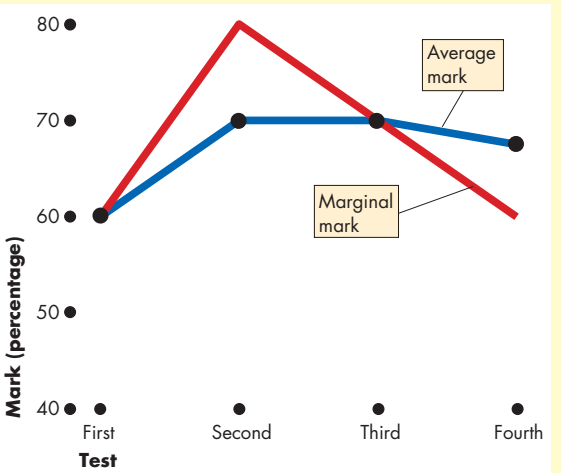

Figure 1 Marginal and Average Mark Curves

REVIEW QUIZ

1. Explain how the marginal product and the average product change as the labour employed increases (a) initially and (b) eventually.
2. What is the law of diminishing returns? Why does marginal product eventually diminish?
3. Explain the relationship between marginal product and average product.

Do these questions in Study Plan 10.2 and get instant feedback. Do a Key Terms Quiz. MyLab Economics

Norma, the owner of Fashion First, cares about Fashion First's product curves because they influence its costs. Let's look at Fashion First's costs.